Abstract

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Population III stars were born in halos of pristine gas composition. In such a halo, once the gas density reaches $n_H \sim 1\text{cm}^{-3}$, molecular cooling leads to the collapse of the gas and the birth of pop III stars. Halo properties, such as chemical abundances, mass, angular momentum can affect the collapse of the gas and thus the pop III initial mass function.

In the paper [Lenoble et al., 2024], we study the properties of primordial halos and how the halos hosting first star formation differ from other halos. The aim of this study is to obtain a representative population of halos at a given redshift that host a cold and massive gas clouds and thus host the birth of the first stars.

We investigate the growth of primordial halos in a large cosmological simulation. We use the code RAMSES [Teyssier, 2002] and the chemical solver KROME [Grassi et al., 2014] to study halo formation with non-equilibrium thermochemistry. We then identify structures in the dark and baryonic matter fields thus linking the presence or absence of dense gas clouds to the mass and the physical properties of the hosting halos.

In our simulations, the mass threshold for a halo to host a cold dense gas cloud is $7 \times 10^5 M_\odot$ and the threshold in H2 mass-fraction is $\sim 2 \times 10^{-4}$. The halo history and accretion rate play a minor role. We found halos with higher HD abundance. These halos are colder as the temperature in the range $10^2 - 10^4\text{cm}^{-3}$ depends a lot on the HD abundance.

References

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